Managing post-weaning stress in piglets: nutritional considerations

Weaning, at whatever age, is a considerable challenge to the young piglet and represents a critical period in its life. It is also the period that establishes its future growth and development, since it is well-known that both the body weight at weaning and performance in the immediate post-weaning period influence its subsequent growth and development through to slaughter.

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The overriding objective at this time should therefore be to ensure as rapid a growth rate as possible through good nutrition, management and health status, as well as the reduction of stress.

Indeed, weaning is perhaps one of the most stressful periods in the life of the pig. It is not just the physical and welfare aspects of stress that need to be reduced, but also the physiological and metabolic aspects of stress associated with changing circumstances, high levels of performance, limited body reserves and considerable mobilisation of body tissue, as well as inadequate feed and nutrient intake immediately after weaning. Nutrition can play an important role in helping to alleviate metabolic and physiological distress.

Role of minerals

Minerals and vitamins are fundamental in combatting stress and may need to be increased if the metabolic function and the antioxidant status of the animal are not to be compromised. This is especially so for sows after their second litter of piglets.

Newton and Mahan (1995) have shown that there is considerable depletion of minerals from their bodies, and the higher the litter size, the greater the rate of mobilisation will be. This will, of course, influence the mineral status of the piglets, as demonstrated by Damgaard Poulsen (1993).

In terms of minerals, one way to overcome this is to include organic rather than inorganic minerals in the diet of the sow and piglets. The total replacement of inorganic minerals with organic minerals (Bioplex, Alltech) in the diet of the sow has been shown to substantially improve litter size and piglets weaned per sow per year.

It also has a major impact on the mineral composition of both colostrum and milk, as well as that of the piglet at birth and weaning (Table 1).

Of particular interest are the trace elements selenium, zinc and copper, which influence antioxidant status and immune function.

Table 1. Comparison of organic and inorganic minerals in pigs.

	Inorganic	Organic	Increase (%)	Source
Newborn piglet				
Liver Fe (mg/kg)	219	278	27	1
Liver Fe (mg/kg)	1779	2171	22	2*
Blood Hb (g/dL)	9.16	11.16	22	2*
Blood Fe (mcg/dL)	174	228	31	2*
Blood Se (mg/L)	0.060	0.092	53	3
Blood Se (mg/g)	0.140	0.159	14	4
Loin Se (mg/kg)	0.116	0.200	72	5
Colostrum				
Colostrum Se (mg/L)	0.093	0.188	202	6
Colostrum Se (mg/L)	0.095	0.168	77	7
Colostrum Se (mg/L)	0.242	0.323	33	4
Colostrum Se (mg/L)	0.205	0.270	32	8
Milk				
Milk Se (mg/L)	0.036	0.105	292	6
Milk Se (mg/L)	0.056	0.101	80	7
Milk Se (mg/L)	0.042	0.087	107	4
Milk Se (mg/L)	0.060	0.098	63	8
Milk Fe (mg/L)	773	1014	31	2*

1. Egeli et al. (1998) 2. Bertechini et al. (2012) 3. Svoboda et al. (2008) 4. Quesnel et al. (2008) 5. Mahan (1994) 6. Mahan (2000) 7. Peters & Mahan (2004) 8. Yoon & McMillar (2006)
*Values at 2 kg/T inclusion rate

Selenium (Se)

Selenium has been shown to be an important dietary antioxidant, and Mahan and Kim (1996) have demonstrated that there is a rapid decline in blood serum and tissue levels of selenium and vitamin E after weaning. This may be due to the low feed intake of the piglets as well as the level in the diet and the availability of the mineral in question.

It is relevant and important to consider the source of Se, as both tissue and loin Se levels were higher when organic Se from Se yeast (Sel-Plex, Alltech) rather than inorganic Se (sodium selenite) was provided in the diet (Table 1). This helps to reduce the metabolic and antioxidant stress on the animals, resulting in enhanced performance, higher immune status and, ultimately, higher health status.

Several studies have shown that when Se yeast is included in the diet, it better supports pre-weaning and post-weaning survivability, as compared with the same level of inorganic sodium selenite.

Zinc (Zn)

Zinc is an essential micronutrient for piglets, and a deficiency results in parakeratosis. Moreover, Zn is involved in many critical functions in the bodies of piglets and is fundamental for optimising protein synthesis and growth, cell proliferation and differentiation, as well as antioxidant defence. It is therefore essential for lean tissue growth and health.

However, distinctions need to be made between the physiological needs for Zn, which has been estimated at 9mg available Zn per day and the high levels commonly provided in the diets of piglets to combat scouring and diarrhoea post-weaning (2,500-3,000mg Zn from ZnOxide). The level of Zn needed in the diet to meet the physiological needs after weaning will depend on the feed intake of the animal and the form and availability of the source of Zn.

In this respect, an interesting study has been carried out by Hill et al. (2014) in which they compared the effects of different levels (0, 25, 50, 75 and 100mg Zn/kg diet) and sources of Zn (organic Bioplex and inorganic sulphate) on the performance and metabolic responses of piglets post-weaning. Although per-

formance was only slightly higher when Zn was provided in the form of Bioplex (p>0.05), the results showed that the bioavailability of Zn from the organic source was greater than that from inorganic Zn, indicating that it better serves the metabolic and physiological functions of the piglet in the post-weaning period (Table 2).

Based on their results, Hill et al. (2014) concluded that the Zn requirements of modern piglets may be higher than originally thought.

Organic minerals appear to be managed differently from inorganic minerals in the body and better support the needs of the piglet to the changing dietary and environmental circumstances immediately post-weaning.

They suggested that to maximise growth, health, well-being and antioxidant defence, the modern high-performing and sensitive piglet post-weaning should be provided with 75mg Fe per kg of diet from organic sources.

These results confirm earlier findings, such as those of Carlson et al. (1999) and Mullan et al. (2002) in relation to both animal performance and metabolic significance.

Copper (Cu)

Copper is an essential nutrient for optimising growth and performance, as well as the development of immunity and health. It plays an important role in the synthesis and activation of several oxidative enzymes necessary for normal metabolism.

The National Research Council (2012) calculated that piglets post-weaning have a Cu requirement of 2.81mg/day, corresponding to a dietary requirement of 6mg/kg.

In practice, diets contain higher levels than this, and including 150mg Cu/kg diet, or indeed higher values, is commonplace in many countries to enhance growth and performance. However, at these high levels, there is the possibility of interference with other nutrients that can reduce their bioavailability. For example, high levels of dietary Cu may reduce the absorption of iron and indirectly result in anaemia.

One way to avoid this is to include organic rather than inorganic sources of Cu in the diets of newly weaned piglets.

For example, Veum et al. (2004) fed young, weaned piglets diets supplemented with increasing levels of organic Cu (Bioplex Cu at 0, 25, 50, 100 and 200mg Cu/kg diet) and 250mg Cu/kg diet as copper sulphate ($CuSO_4$).

Feed intake was highest at 25 and 50mg Cu/kg diet from the organic source. Growth rate increased up to 50mg Cu/kg diet, with no further increases above this level; feed efficiency was not affected by dietary treatment.

Rates of absorption of both Cu and Zn were considerably higher from the organic sources of Cu, leading to reduced mineral excretion rates.

The results of these and other studies suggest that providing 50-100mg Cu/kg to piglets from organic (Bioplex) Cu gives similar performance to 150-250mg Cu/kg from $CuSO_4$, with considerably reduced rates of Cu excretion.

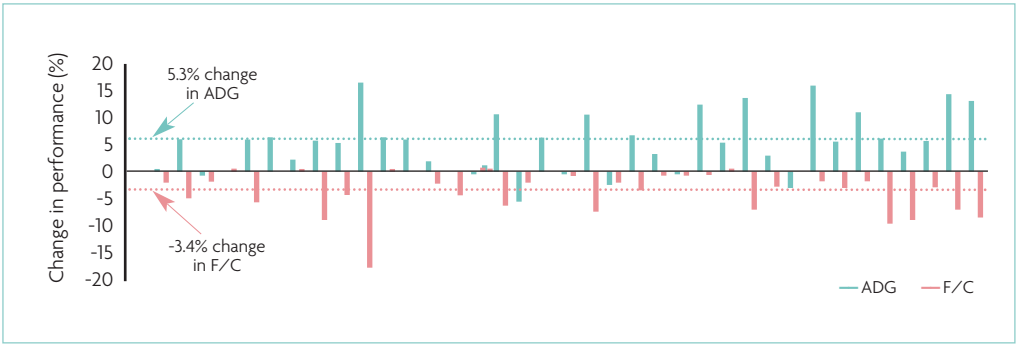

Fig. 1. Improvement in ADG and F/C with NuPro yeast derived protein.

Mineral supply

Although Fe and Mn are important, they are not discussed in this article. However, providing them in organic form is recommended. Indeed, the total replacement of all inorganic minerals by lower levels of organic minerals is highly recommended for piglets post-weaning.

Dietary ingredients

After weaning, piglets require a good intake of a highly digestible diet to optimise performance. The choice of ingredients to supply these essential nutrients is critical, as certain dietary ingredients provide not only nutrients, but may also have proactive compounds that improve health, well-being and performance.

NuPro (Yeast Derived Protein, YDP, Alltech) is a source of digestible nutrients and also provides other proactive properties, such as nucleotides, inositol and glutamine. These support intestinal function, promote gut integrity, support the immune response and stimulate appetite, which results in optimised health and performance well above the value of its nutrient content.

From a meta-analysis of 38 studies comparing NuPro with a range of highly digestible ingredients normally included in piglet diets, there was a 5.3% improvement in growth rate and a 3.4% better feed conversion efficiency (Fig. 1). This improvement resulted in piglets being 1kg heavier some four weeks after weaning.

The increase in performance suggests that the response to NuPro is above the sum of its nutrient content, and it is interesting to speculate why this occurs.

Studies have shown that intestinal health is improved, and there is a concomitant increase in beneficial bacteria. There is also an enhancement of immune function as well as healing of any gut wall damage.

The physiological stress associated with weaning may be reduced, since the concentration of the acute-phase protein haptoglobin in the blood of piglets post-weaning was reduced. Absorptive capacity of the gut may be increased, as it has been shown that the villus height to crypt depth ratio is increased, which results in enhanced nutrient utilisation.

The overall response measured from several studies was a 10% increase in the ratio (range 1.5-27.6%). All of these contribute to better gastrointestinal health and immune function, enhanced digestive competence and reduced metabolic distress, which result in better growth, feed conversion efficiency and overall performance.

Conclusions

Weaning is a very sensitive and stressful period in the life of the pig, with consequences through to slaughter.

Ensuring that the nutritional requirements of the animals are met by providing the most available nutrients and proactive ingredients in the diet to reduce metabolic and physiological distress will be fundamental to ensuring optimum growth, feed efficiency, health and profitable piglet production. ■

References are available from the author on request

Table 2. The effects of source and level of zinc on the performance and metabolic function in nursery pigs (Hill et al. 2014).

Zinc source	Basal	Organic Zn				Inorganic Zn				Combination
Zn level (mg/kg)	0	25	50	75	100	25	50	75	100	25+10
Feed intake (g/d)	534	542	552	578	540	574	537	552	563	555
Growth rate (g/d)	318	370	378	397	366	387	362	365	373	378
Feed: gain (g/g)	1.74	1.43	1.46	1.50	1.47	1.48	1.48	1.67	1.51	1.47
Liver content (mg/liver)	19.1	22.6	36.7	43.7	58.3	27.9	33.6	43.7	49.9	36.1
Metallothionein conc. duodenum (mg/g tissue)	30.2	33.3	34.6	37.8	50.1	30.5	32.0	40.6	40.6	33.7